How do we remember events?

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How do we remember events?

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Abstract

Episodic memory was first described as the memory system that receives and stores information about events [1]. Since then, studies of episodic memory have tended to use simple, highly controlled stimuli to probe its cognitive and neural underpinnings. By contrast, the study of "event memory" has focussed more on memory function in more real-world situations, or used naturalistic stimuli such as movies as a stand-in for reality [2]. Recently there has been an explosion in studies that have combined cognitive experiments using naturalistic stimuli with neuroimaging techniques such as fMRI and EEG, to shed light on how the brain underpins event memory. This review summarises the achievements of these studies and highlights areas that await further work.

Introduction

We experience the world via a continuous stream of sensory information. However, when we later remember what has happened to us, we tend to recall a sequence of events. This re-processing of experience into event-units is termed event segmentation. Boundaries between successive events occur when there is a change to the current situation, such the arrival of a new person or a change in location. The fact that we segment experience in this way has profound effects on how we perceive and attend to the world around us. In this review, I will focus on those aspects of event processing that relate to how we later remember events.

"Event models" and Event Segmentation Theory

The cognitive processes underpinning event segmentation have been described by Jeffrey Zacks and colleagues in their Event Segmentation Theory [EST: 3]. More recently they related aspects of EST to specific brain regions and networks [4, 5]. According to the theory, mental "event models" describe the salient features of a situation, such as the location, people present and their actions and intentions. The currently active event model is thought to be held in working memory. Detection of a boundary between two successive events triggers: (1) the creation of a new event model to describe the changed situation, and (2) the encoding of the previous event model into long-term memory [4, 6]. When we later remember our experiences, we reactivate the event models that describe particular events from the past, as well as retrieve more specific information about what happened.

Evidence for event models in the brain

Several recent studies have scanned participants using functional MRI while they first watch, and then freely recall either whole movies or movie clips [7-11]. For example, Oedekoven et al., [9] had participants watch and then retrieve 40s movie clips and then a week later they retrieved the clips again in the scanner. The clips involved different narratives, characters and locations. Representational similarity analyses showed that patterns of brain activity while watching and retrieving the same movie clip were more similar than when retrieving other movie clips (Fig. 1A-B). Similar results were found by Chen and colleagues [11], who asked participants to watch and then recall an extended movie. They also showed reinstatement of event patterns across various brain

regions, even though the “events” were successive scenes within a continuous movie. In all these studies, the event patterns were averaged across the whole clip or scene, and therefore likely reflect the those stable elements of the event which comprise it’s event model, rather than rapidly changing information.

The study by Chen et al. (2017) also reported a dramatic new finding; event specific patterns of brain activity are similar across individuals (Fig. 1C). The authors suggested that patterns of brain activity index separate event models, and that the striking similarity across individuals may offer a clue as to how we communicate information about events to other people. A follow-up study of the same dataset tested whether event boundaries could be detected using a purely data driven approach [6]. The authors detected brain regions where patterns of brain activity remained stable and then rapidly shifted. Interestingly, the patterns remained stable for relatively short periods in brain regions associated with sensory processing, while in the longest timescales regions, the shifts in patterns corresponded to event boundaries as identified by human observers. Other studies have shown that event patterns are also similar when listening to a verbal description of an event as well as when watching and remembering the same event [12].

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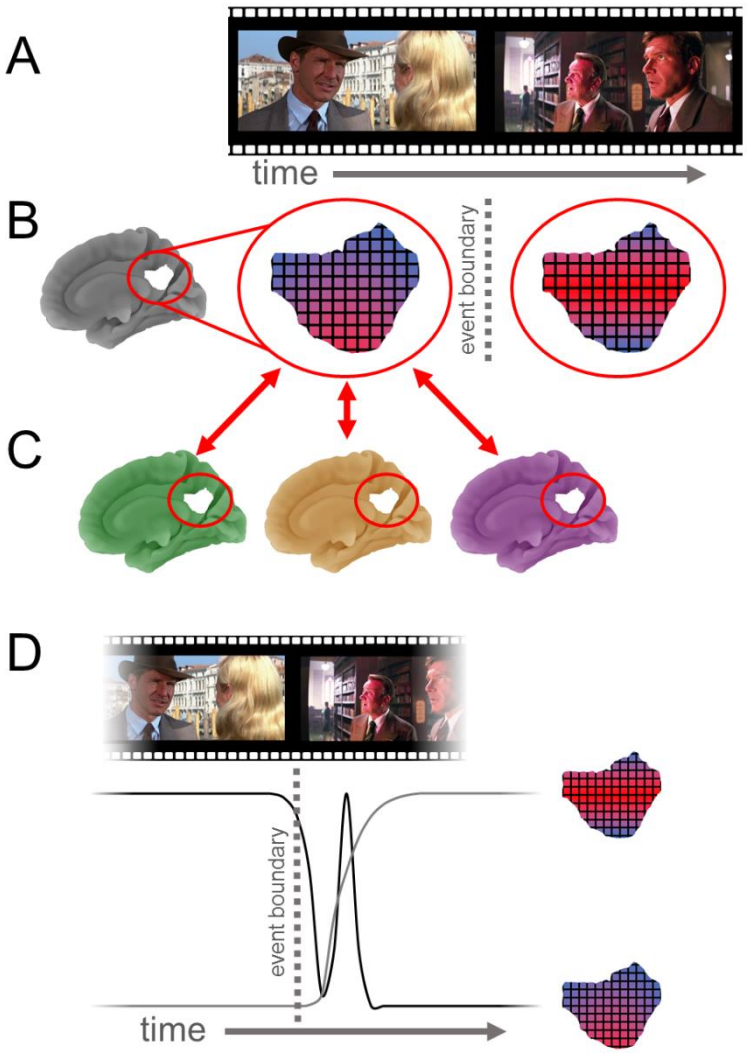
Figure 1: Representations of events in the brain



Legend:

Event processing in the brain. (A) Movies comprise a sequence of events lasting in the order of tens of seconds to a few minutes, separated by event boundaries. (B) Within regions of the PM network, especially posterior midline cortex (shown in white), patterns of brain activity are relatively stable within events and different between events [10]. Event-specific patterns are spatially smooth and present over large regions of cortex [11, 13]. Recalling the event reinstates the event-specific pattern of brain activity, both at short (same session) and long (one week) delays [9]. (C) Event-specific patterns of brain activity are similar across individuals [represented by different coloured brains. 11]. (D) Event boundaries are associated with a transient hippocampal activation (not shown) and by a brief reinstatement of the pattern of activity associated with the preceding event [14]. This effect has been demonstrated using surface EEG measurements and may occur in PM regions. All images show simulated, not real, data, based on the cited studies. Figure 1A copyright, Paramount Pictures.

Where in the brain are event models represented?

Event-specific patterns of brain activity are observed across widespread regions of the brain. These include the fusiform gyrus / parahippocampal gyrus, posterior middle temporal gyrus, superior lateral occipital cortex / angular gyrus and the posterior midline cortex, particularly the precuneus and posterior cingulate [7-11]. These regions largely correspond to those identified by Ranganath and Ritchey [15] as comprising the brain's "posterior medial" network, which the authors associated with the representation of event models. Others have characterised these regions as supporting "context" in the broad sense of stereotyped places such as a supermarket or kitchen [16]. Moreover, Hasson and colleagues have demonstrated that these areas integrate incoming information over long timescales of up to a few minutes [17].

Recently, two studies have shown that processing of events within the PM network is not disrupted in patients with very dense amnesia associated with medial temporal lobe or thalamic damage [18, 19]. This is consistent with the observation that amnesic patients often are able to comprehend an event or narrative as it is unfolding, despite being unable to then recall it a short time later. Moreover, it supports the conclusion that the PM network maintains an "online" representation of an event. Nevertheless, the study by Oedekoven and colleagues suggested that functional connectivity between the posterior midline cortex and the hippocampus was required in order to later remember the events.

What drives event-specific patterns of activity?

Spatial information has long been argued to be "scaffold" for episodic memory [20] and an fMRI study recently argued that locations dominate the cortical representation of an event [21]. However, the locations typically used in studies of episodic memory are also conceptually very different from each other – e.g. a kitchen, a gym and a cinema. A recent study showed that patterns of brain activity across individuals are similar when people process events that are conceptually similar [or share the same event "schema", 13]. Watching or listening to events involving the same event schemas, such as being at an airport, resulted in patterns of brain activity that were consistent within and across individuals, despite the fact that the different events were set in different physical locations.

It seems likely therefore, that event-specific patterns of brain activity reflect abstract and "gist" level descriptions of the content of the event. It is also possible that the key drivers of event-specific activity patterns vary according to the specific event: in a movie involving several changes of location, this might be the critical feature, whereas in a movie set in a single location but involving different goal-related activities, the completion of a goal might prove to be most important.

Events enable the relationships between items to be bound together

Relationships between items experienced within one context are remembered better than items experienced across contexts [22-24]. For example, the order of objects encountered on a path through different rooms is remembered better for objects that occurred in the same room rather than an adjoining one, even if the absolute distance between the successive objects is the same [24] (see also [25]). Similarly, when "events" are defined as sequences of pictures of the same category of items, and event boundaries are signalled by pictures of objects from a different category, memory for the temporal order of items is better for those occurring within the same event [26] (see [27] for a recent review of these findings). Building on this, DuBrow and Davachi [23] used fMRI to show that

when the temporal order of the items within a run was remembered better, hippocampal pattern similarity of the items within the sequence was increased. This suggests that the more stable the representation of the overall event, the better items occurring within that event are linked together in memory. Horner et al., came to the same conclusion, where they modelled memory for items as being associated with a drifting "context" signal [24]. Importantly, they assumed that an event boundary caused the context signal for more rapidly shift, resulting in better associative memory for items occurring within the same event compared to a different one [see also, 27, 28].

Memory encoding at event boundaries

When participants watch an extended movie, event boundaries are associated with brief increases in fMRI activity in many brain regions [29]. Moreover, within the hippocampus, transitory responses at the end of events are larger when those events can be subsequently recalled [30, 31]. Similar hippocampal responses also occur at event boundaries within longer movies and the magnitude of these responses are related to the salience of the event boundary ([32] see also [6]).

A recent study leveraged the high temporal resolution of EEG to shed more light on the processes occurring at event boundaries. Silva et al., [14], had participants watch a continuous movie and then recall it. The authors showed that for subsequently remembered events, the EEG patterns of activity from the 10 seconds prior to an event boundary were reinstated within a time-window of about 2 seconds after an event boundary (for a similar study using sequences for pictures organised into "events", see [33]). Thus, event boundaries not only trigger a hippocampus response but also appear to instigate a rapid cortical "replay" of elements of the preceding event, with both effects being related to subsequent memory (Fig. 1D).

Processing at event boundaries is likely to involve the linking together in memory of successive event models, in order that there temporal structure of a series of events can be later recalled. Using their picture sequence event memory task, DuBrow and Davachi [34] showed that activity in the hippocampus and left lateral prefrontal cortex increased when participants successfully recalled items that spanned an event boundary. Thus, the hippocampus not only plays a role in both encoding the previous event but also in linking successive events in long-term memory.

The influence of prior knowledge on event processing and memory

An important component of EST is that event models are not constructed only on the basis of incoming sensory information, but also from long-term knowledge (or "event schemas"). Prior knowledge has long been known to play an important role in how we remember events, generally improving memory [35-37], but sometimes distorting it to be more in line with our expectations [38, 39]. In recent years we have learned more about the interactions between prior knowledge and event processing in the brain.

A popular technique used to manipulate prior knowledge is to show participants either the first part of a movie, or a scrambled or altered version of the first part. Then, fMRI activity is measured when participants watch the conclusion of the movie, where the only difference between conditions is the knowledge that the participants already have about the preceding events [40-42]. Chen et al. [41], showed the brain activity was correlated across individuals who shared prior knowledge of the movie – an effect that was observed within the PM network as well as the wider "default mode network" [43]. Keidel and colleagues [42] provided evidence that different regions within the PM network may support different aspects of event processing. Participants viewed either the first half

of a movie clip, or an “alternative” first half that included the same characters and location, but depicted a different event. Prior knowledge affected processing in PM regions, but there was a differential effect in the time-course of brain activity; transient responses were observed in the parahippocampal and retrosplenial cortices, whereas sustained responses were found in the middle temporal and angular gyri (see also [44]). The authors suggested that the transient responses could reflect the establishment of the context of the event model (e.g. characters and locations), whereas sustained responses might represent the integration of information about the narrative as it unfolds over time.

Conclusions and future directions

Recently, we have made rapid progress in our understanding of how complex, naturalistic events are remembered. In particular, we have begun to establish how the psychological processes underpinning event memory are instantiated in the brain. These have been incorporated into recent models of event processing [4, 5, 27, 45]. Indeed, some insights about the nature of event processing in the brain have arisen directly from the predictions of models [6].

These advances have been made largely through the combination of carefully designed tasks and innovative analyses of fMRI data. The spatial and temporal resolution of fMRI makes it suitable for detecting the engagement of relatively large brain regions in particular aspects of event processing, such as the representation of the overarching content of events. It remains to be seen whether fMRI will enable us to tease apart the differential contribution of neuronal populations within regions or shed insight into how processing within different cortical regions represents the fine-grained elements of complex events. However, the increasing use of EEG, MEG and intracranial recordings may well provide new opportunities to tackle these issues.

BOX 1

Event models and context – different terms for the same thing?

Event models are defined as multi-dimensional, combining multiple elements that describe the "what", "where" and "when" of a particular situation. By contrast, "context" often refers to a particular dimension, notably space ("where") and time ("when"). There are advantages to focussing only on one dimension, particularly the fact that it is possible to identify neuronal populations that respond specifically to particular aspects of them (e.g. "place" cells and "time" cells"[46, 47]). However, non-spatial changes can cause place cells to "remap", or module the firing of place cells, suggesting multidimensional influences on the representation of spatial context (e.g. [48]).

It is tempting to see cortical patterns that correspond to particular event models as similar to place cell ensembles – "remapping" which cells are active when an event boundary triggers the establishment of a new event model. However, this is highly unlikely to be the case. Event-specific patterns of BOLD activity extend of large regions of cortex and are reproducible across individuals (illustrated in Figure 1B, see Chen et al., 2017, and Baldassano et al., 2018, for real examples). By contrast, coding of location in the hippocampus is relatively sparse, has no clear topographical organisation within an individual rodent [49], and is not similar across individual rodents.

More recent models of episodic memory have emphasised the critical role of context in memory, but where context explicitly comprises multiple elements that change over time at different rates and correspond to dimensions such as location, time, mood, activity, and so on [28, 50]. This conceptualisation of context is broadly comparable to the notion of an event model.

BOX 2

How long does an event last?

In this review, “events” refer to units of experience that are coherent and meaningful, lasting in the order of tens of seconds to a few minutes. This corresponds to the length of events that are obtained if healthy adults are asked to identify events boundaries in a movie – a task which can typically be carried out with minimal instruction and in a way that is remarkably consistent across individuals [51]. It is assumed that the contents of an ongoing event can be represented within working memory, consistent with William James’s concept of a “specious present” being the duration of experience that we are currently aware of without having to retrieve information from the genuine past [52].

Of course, we may characterise events as lasting much longer than this – a single journey or a party might last several hours. However, although we might have knowledge about what happened over the entire course of the journey or party, our specific episodic memories will always relate to particular incidents that occurred within a much shorter timeframe.

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References:

1. Tulving, E., *Episodic and semantic memory*, in *Organization of memory*, E.D. Tulving, W., Editor. 1972, Academic Press: New York.
2. Radvansky, G.A. and J.M. Zacks, *Event Cognition*. 2014: Oxford University Press.
3. Zacks, J.M., et al., *Event perception: a mind-brain perspective.* Psychol Bull, 2007. **133**(2): p. 273-93.
4. Richmond, L.L. and J.M. Zacks, *Constructing Experience: Event Models from Perception to Action.* Trends Cogn Sci, 2017. **21**(12): p. 962-980.
5. Stawarczyk, D., M.A. Bezdek, and J.M. Zacks, *Event Representations and Predictive Processing: The Role of the Midline Default Network Core.* Top Cogn Sci, 2019.
6. Baldassano, C., et al., *Discovering Event Structure in Continuous Narrative Perception and Memory.* Neuron, 2017. **95**(3): p. 709-721 e5.
7. St-Laurent, M., et al., *The temporal unraveling of autobiographical memory narratives in patients with temporal lobe epilepsy or excisions.* Hippocampus, 2011. **21**(4): p. 409-21.
8. Buchsbaum, B.R., et al., *The neural basis of vivid memory is patterned on perception.* J Cogn Neurosci, 2012. **24**(9): p. 1867-83.
9. Oedekoven, C.S.H., et al., *Reinstatement of memory representations for lifelike events over the course of a week.* Sci Rep, 2017. **7**(1): p. 14305.
10. Bird, C.M., et al., *Consolidation of Complex Events via Reinstatement in Posterior Cingulate Cortex.* J Neurosci, 2015. **35**(43): p. 14426-34.
11. Chen, J., et al., *Shared memories reveal shared structure in neural activity across individuals.* Nat Neurosci, 2017. **20**(1): p. 115-125.
12. Zadbood, A., et al., *How We Transmit Memories to Other Brains: Constructing Shared Neural Representations Via Communication.* Cereb Cortex, 2017. **27**(10): p. 4988-5000.
13. Baldassano, C., U. Hasson, and K.A. Norman, *Representation of Real-World Event Schemas during Narrative Perception.* J Neurosci, 2018. **38**(45): p. 9689-9699.
14. Silva, M., C. Baldassano, and L. Fuentemilla, *Rapid memory reactivation at movie event boundaries promotes episodic encoding.* J Neurosci, 2019.
15. Ranganath, C. and M. Ritchey, *Two cortical systems for memory-guided behaviour.* Nat Rev Neurosci, 2012. **13**(10): p. 713-26.
16. Bar, M. and E. Aminoff, *Cortical analysis of visual context.* Neuron, 2003. **38**(2): p. 347-58.
17. Hasson, U., J. Chen, and C.J. Honey, *Hierarchical process memory: memory as an integral component of information processing.* Trends Cogn Sci, 2015. **19**(6): p. 304-13.
18. Zuo, X., et al., *Temporal integration of narrative information in a hippocampal amnesic patient.* bioRxiv, 2019: p. 713180.
19. Oedekoven, C.S.H., et al., *Effects of amnesia on processing in the hippocampus and default mode network during a naturalistic memory task: A case study.* Neuropsychologia, 2019. **132**: p. 107104.
20. O'Keefe, J. and L. Nadel, *The hippocampus as a cognitive map*. 1978, Oxford: Clarendon Press.
21. Robin, J., B.R. Buchsbaum, and M. Moscovitch, *The primacy of spatial context in the neural representation of events.* The Journal of Neuroscience, 2018.
22. Ezzyat, Y. and L. Davachi, *Similarity breeds proximity: pattern similarity within and across contexts is related to later mnemonic judgments of temporal proximity.* Neuron, 2014. **81**(5): p. 1179-1189.
23. DuBrow, S. and L. Davachi, *Temporal memory is shaped by encoding stability and intervening item reactivation.* J Neurosci, 2014. **34**(42): p. 13998-4005.
24. Horner, A.J., et al., *The role of spatial boundaries in shaping long-term event representations.* Cognition, 2016. **154**: p. 151-164.

25. Radvansky, G.A. and J.M. Zacks, *Event Boundaries in Memory and Cognition.* Curr Opin Behav Sci, 2017. **17**: p. 133-140.
26. DuBrow, S. and L. Davachi, *The influence of context boundaries on memory for the sequential order of events.* J Exp Psychol Gen, 2013. **142**(4): p. 1277-86.
27. Clewett, D., S. DuBrow, and L. Davachi, *Transcending time in the brain: How event memories are constructed from experience.* Hippocampus, 2019. **29**(3): p. 162-183.
28. DuBrow, S., et al., *Does mental context drift or shift?* Curr Opin Behav Sci, 2017. **17**: p. 141-146.
29. Zacks, J.M., et al., *Human brain activity time-locked to perceptual event boundaries.* Nat Neurosci, 2001. **4**(6): p. 651-5.
30. Ben-Yakov, A., N. Eshel, and Y. Dudai, *Hippocampal immediate poststimulus activity in the encoding of consecutive naturalistic episodes.* Journal of experimental psychology. General, 2013. **142**(4): p. 1255-63.
31. Ben-Yakov, A. and Y. Dudai, *Constructing realistic engrams: poststimulus activity of hippocampus and dorsal striatum predicts subsequent episodic memory.* Journal of neuroscience, 2011. **31**(24): p. 9032-42.
32. Ben-Yakov, A. and R.N. Henson, *The Hippocampal Film Editor: Sensitivity and Specificity to Event Boundaries in Continuous Experience.* J Neurosci, 2018. **38**(47): p. 10057-10068.
33. Sols, I., et al., *Event Boundaries Trigger Rapid Memory Reinstatement of the Prior Events to Promote Their Representation in Long-Term Memory.* Curr Biol, 2017. **27**(22): p. 3499-3504 e4.
34. DuBrow, S. and L. Davachi, *Temporal binding within and across events.* Neurobiol Learn Mem, 2016. **134 Pt A**: p. 107-114.
35. Bransford, J.D. and M.K. Johnson, *Contextual Prerequisites for Understanding - Some Investigations of Comprehension and Recall.* Journal of Verbal Learning and Verbal Behavior, 1972. **11**(6): p. 717-726.
36. Klatzky, R.L. and F.H. Forrest, *Recognizing Familiar and Unfamiliar Faces.* Memory & Cognition, 1984. **12**(1): p. 60-70.
37. Chiesi, H.L., G.J. Spilich, and J.F. Voss, *Acquisition of Domain-Related Information in Relation to High and Low Domain Knowledge.* Journal of Verbal Learning and Verbal Behavior, 1979. **18**(3): p. 257-273.
38. Bartlett, F.C., *Remembering*. 1932, London: Cambridge University Press.
39. Brewer, W.F. and J.C. Treyens, *Role of Schemata in Memory for Places.* Cognitive Psychology, 1981. **13**(2): p. 207-230.
40. van Kesteren, M.T., et al., *Persistent schema-dependent hippocampal-neocortical connectivity during memory encoding and postencoding rest in humans.* Proc Natl Acad Sci U S A, 2010. **107**(16): p. 7550-5.
41. Chen, J., et al., *Accessing Real-Life Episodic Information from Minutes versus Hours Earlier Modulates Hippocampal and High-Order Cortical Dynamics.* Cereb Cortex, 2016. **26**(8): p. 3428-3441.
42. Keidel, J.L., et al., *Multiscale Integration of Contextual Information During a Naturalistic Task.* Cereb Cortex, 2018. **28**(10): p. 3531-3539.
43. Raichle, M.E., et al., *A default mode of brain function.* Proc Natl Acad Sci U S A, 2001. **98**(2): p. 676-82.
44. Raykov, P., J.L. Keidel, and C.M. Bird, *Shared contextual knowledge strengthens inter-subject synchrony and pattern similarity in the semantic network*. 2018: www.bioRXiv.org.
45. Franklin, N., et al., *Structured event memory: a neuro-symbolic model of event cognition.* BioRxiv, 2019: p. 541607.
46. O'Keefe, J., *Place units in the hippocampus of the freely moving rat.* Exp Neurol, 1976. **51**(1): p. 78-109.

47. MacDonald, C.J., et al., *Hippocampal "time cells" bridge the gap in memory for discontiguous events.* Neuron, 2011. **71**(4): p. 737-49.
48. Colgin, L.L., *Five Decades of Hippocampal Place Cells and EEG Rhythms in Behaving Rats.* J Neurosci, 2019.
49. Dombeck, D.A., et al., *Functional imaging of hippocampal place cells at cellular resolution during virtual navigation.* Nat Neurosci, 2010. **13**(11): p. 1433-40.
50. Yonelinas, A.P., et al., *A contextual binding theory of episodic memory: systems consolidation reconsidered.* Nat Rev Neurosci, 2019. **20**(6): p. 364-375.
51. Newtson, D., *Attribution and the unit of perception of ongoing behavior.* Journal of Personality and Social Psychology, 1973. **28**: p. 28-38.
52. James, W., *The Principles of Psychology*. 1890, New York: Henry Holt.

Annotated References:

Baldassano, C., Chen, J., Zadbood, A., Pillow, J. W., Hasson, U., & Norman, K. A. (2017). Discovering Event Structure in Continuous Narrative Perception and Memory. Neuron, 95(3), 709-721 e705. doi:10.1016/j.neuron.2017.06.041

** Applied a novel model of event processing to segment a movie into events based on fMRI data.

Ben-Yakov, A., & Dudai, Y. (2011). Constructing realistic engrams: poststimulus activity of hippocampus and dorsal striatum predicts subsequent episodic memory. Journal of neuroscience, 31(24), 9032-9042. doi:10.1523/JNEUROSCI.0702-11.2011

** Showed that the hippocampus responds to the offsets of extended events and the magnitude of the response is related to memory for the event.

Bird, C. M., Keidel, J. L., Ing, L. P., Horner, A. J., & Burgess, N. (2015). Consolidation of Complex Events via Reinstatement in Posterior Cingulate Cortex. J Neurosci, 35(43), 14426-14434. doi:10.1523/JNEUROSCI.1774-15.2015

* Showed that events are associated with specific patterns of brain activity that are reinstated during recall and that the degree of reinstatement correlates with delayed recall of the events.

Chen, J., Leong, Y. C., Honey, C. J., Yong, C. H., Norman, K. A., & Hasson, U. (2017). Shared memories reveal shared structure in neural activity across individuals. Nat Neurosci, 20(1), 115-125. doi:10.1038/nn.4450

** Demonstrated that event-related patterns of activity of scenes from a continuous movie are reinstated when the same scenes are recalled and that the patterns are similar across individuals throughout the default mode network.

Clewett, D., DuBrow, S., & Davachi, L. (2019). Transcending time in the brain: How event memories are constructed from experience. Hippocampus, 29(3), 162-183. doi:10.1002/hipo.23074

** Excellent review of the cognitive neuroscience of event memory

Ranganath, C., & Ritchey, M. (2012). Two cortical systems for memory-guided behaviour. Nat Rev Neurosci, 13(10), 713-726. doi:10.1038/nrn3338

* Landmark review of the evidence for separate posterior medial and anterior temporal brain networks supporting memory processing. Situation models are argued to be supported by the posterior medial network.

Silva, M., Baldassano, C., & Fuentemilla, L. (2019). Rapid memory reactivation at movie event boundaries promotes episodic encoding. J Neurosci. doi:10.1523/JNEUROSCI.0360-19.2019

* Demonstrated that when scenes from a movie are later recalled, the EEG pattern of activity from the last 10 seconds of the scene is reactivated during the first 2 seconds of the subsequent scene. Also showed that event-specific patterns of EEG data are similar across individuals.

Zacks, J. M. (2019). Event perception and memory. Annual Review of Psychology.

** A comprehensive and recent review of event processing and Event Segmentation Theory.

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Highlights:

Event models describe salient features of an event

Event models are indexed by fMRI patterns of activity in the brain's posterior medial memory network

Event boundaries trigger a shift in event patterns and a brief hippocampal response

These fMRI effects reflect the online representation of events and their encoding into memory